

# Dewetting and Segregation of Zn-Doped InSb in Microgravity Experiments

A. G. Ostrogorsky<sup>a</sup>, C. Marin<sup>a</sup>, M. P. Volz<sup>b</sup>, T. Duffar<sup>c</sup>

<sup>a</sup>Rensselaer Polytechnic Institute, Troy, NY, USA

<sup>b</sup>NASA/Marshall Space Flight Center, EM30, Huntsville, AL , USA

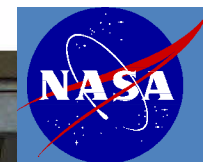
<sup>c</sup>SIMAP-EPM, BP75, Saint Martin d'Heres, France



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# Introduction

- Three Zn-doped InSb crystals were directionally solidified under microgravity conditions at the International Space Station
- The samples were processed in the Microgravity Science Glovebox
- The samples were grown by a Vertical Gradient Freeze technique. The furnace allowed for real-time visualization of the solid-liquid interface.
- Static pressure of  $\sim 4000 \text{ N/m}^2$  was imposed on the melt using a piston driven by a carbon spring in 2 of the 3 samples to prevent bubble formation and de-wetting
- X-ray tomography was used to identify the final positions of the carbon baffles inside the samples
- The distribution of Zn was measured using SIMS



SAMS-II SE  
on ceiling.  
*Provided by  
NASA GRC*

SAMS-II Electronics  
Enclosure (EE).  
*Provided by NASA  
Glenn Research Center*

SUBSA/PFMI  
Process Control  
Module (PCM)

SUBSA  
Thermal Chamber

SUBSA/PFMI DaqPad (slides in  
brackets under PCM)

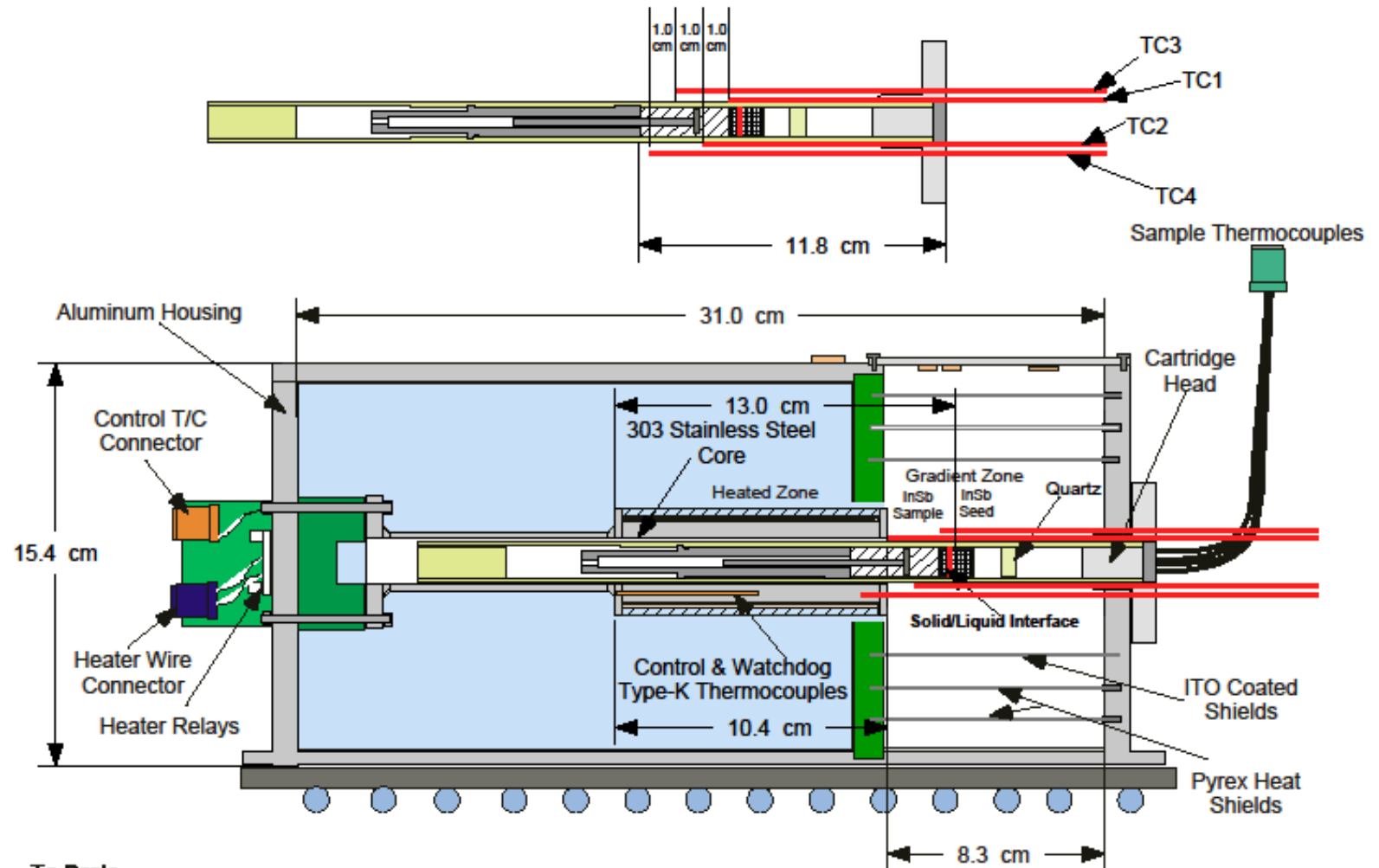
SUBSA Camera  
Stage Assembly

SUBSA/PFMI Cohu 3812  
video camera

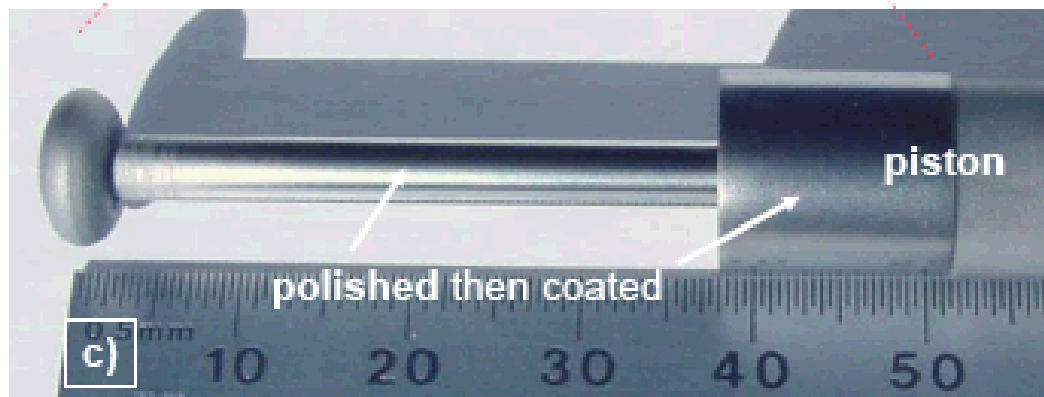
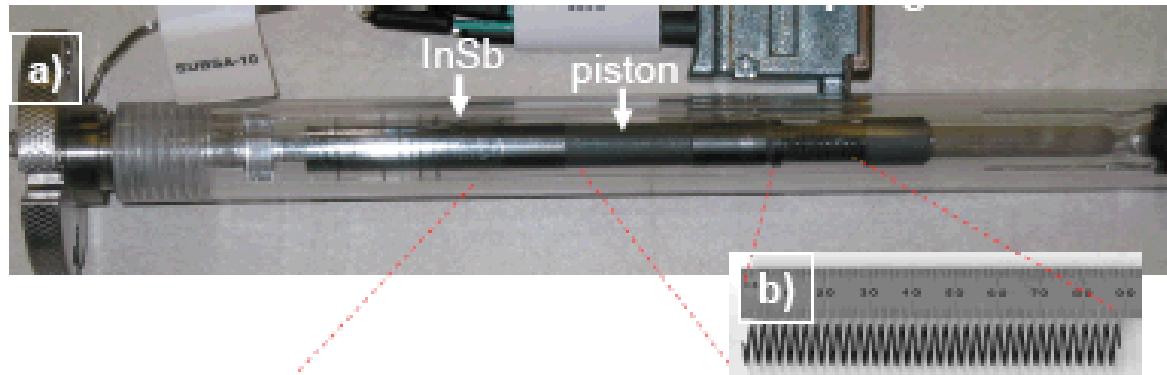
MSG Spotlight.  
*MSG-provided*



# SUBSA Furnace

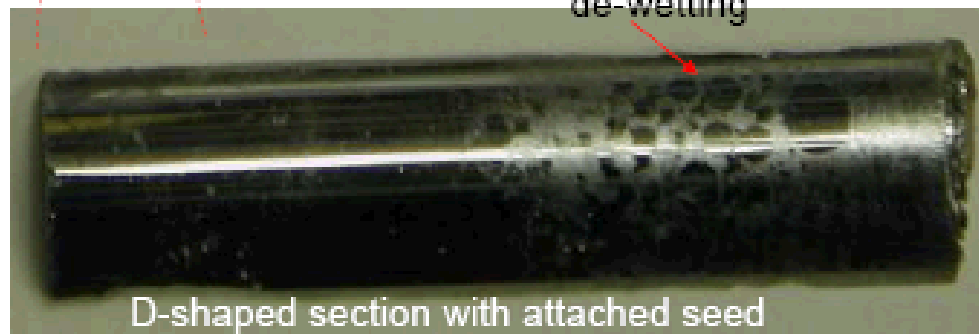
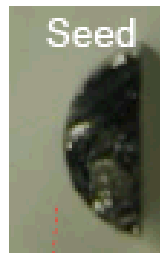
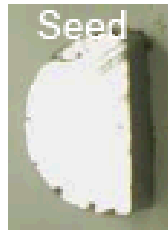


# Ampoule Components

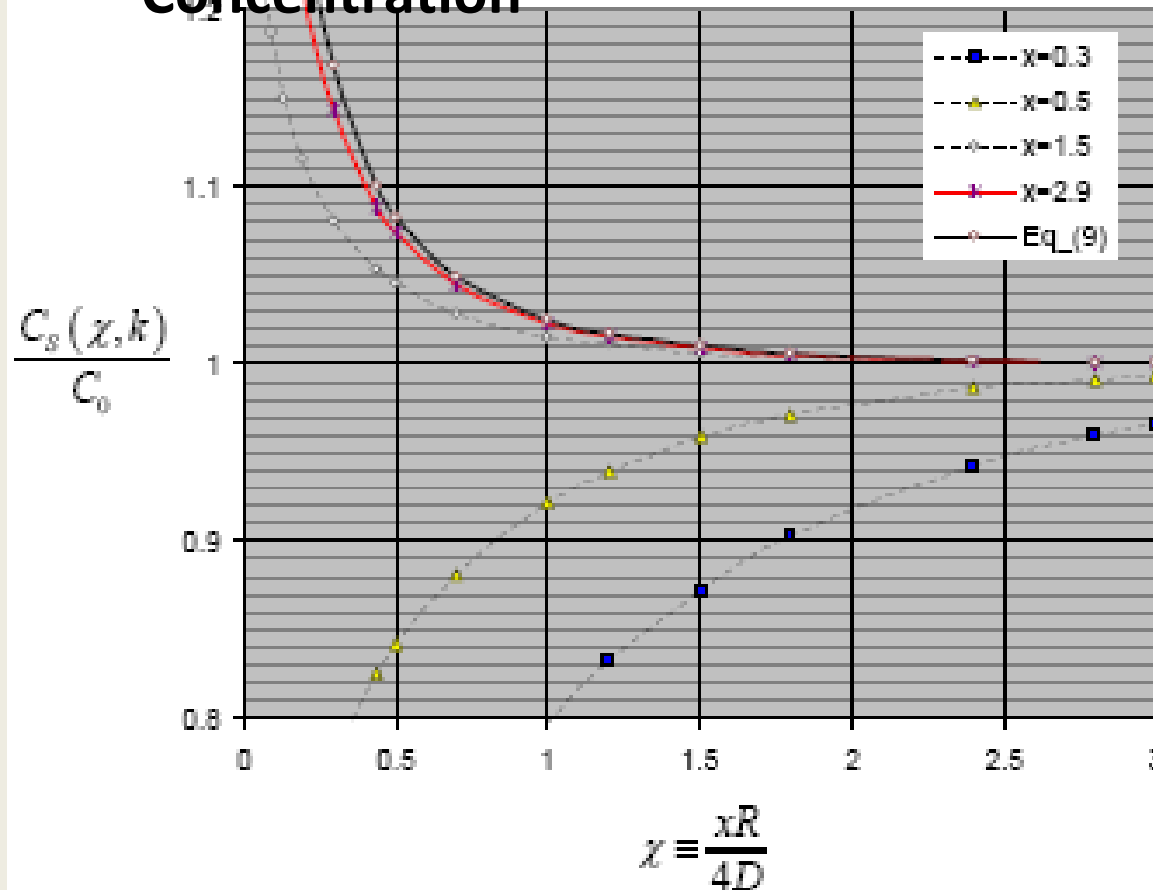




## SUBSA-10 Post-growth Sample Processing

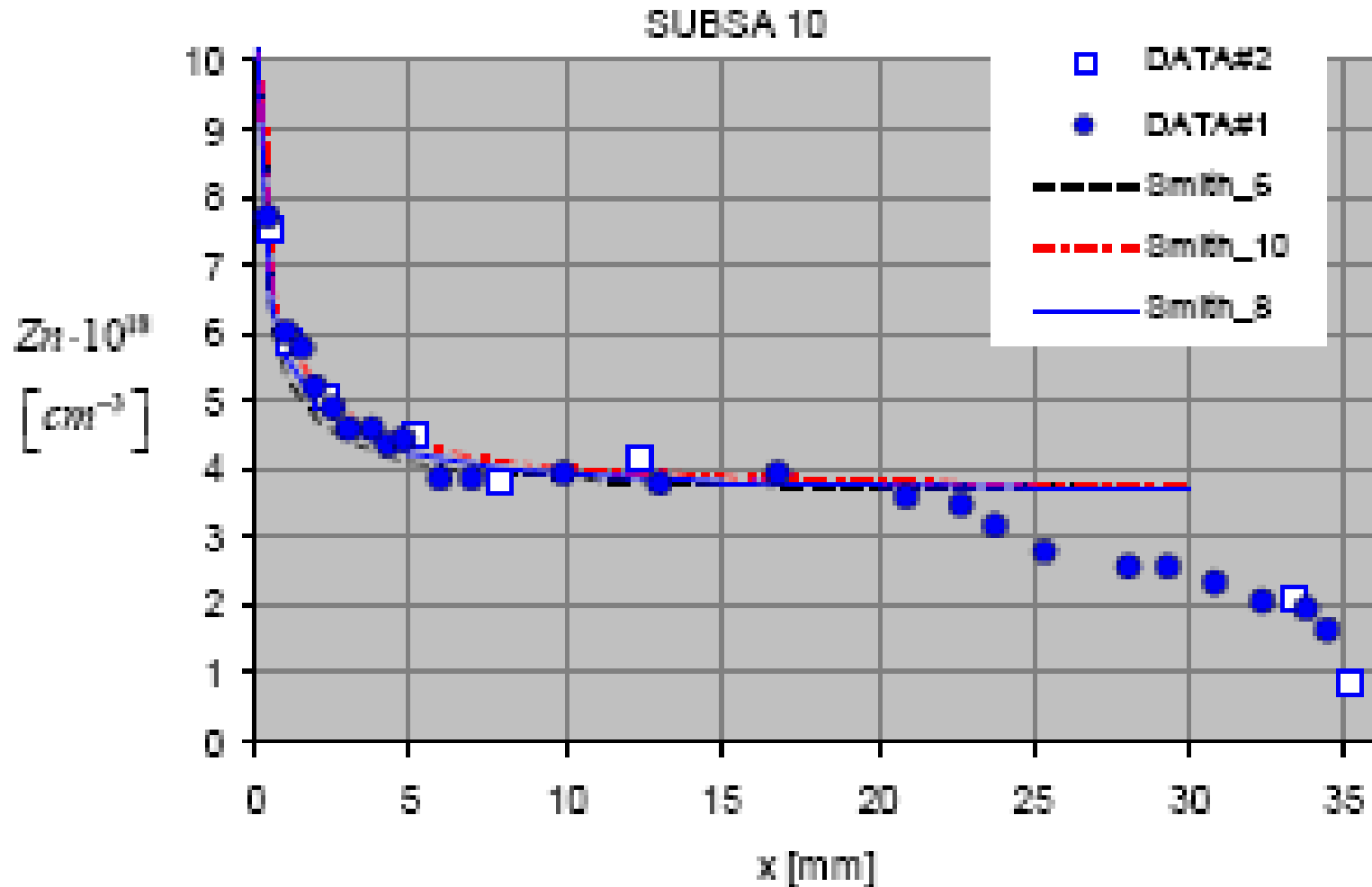


## Initial Transient in Dopant Concentration



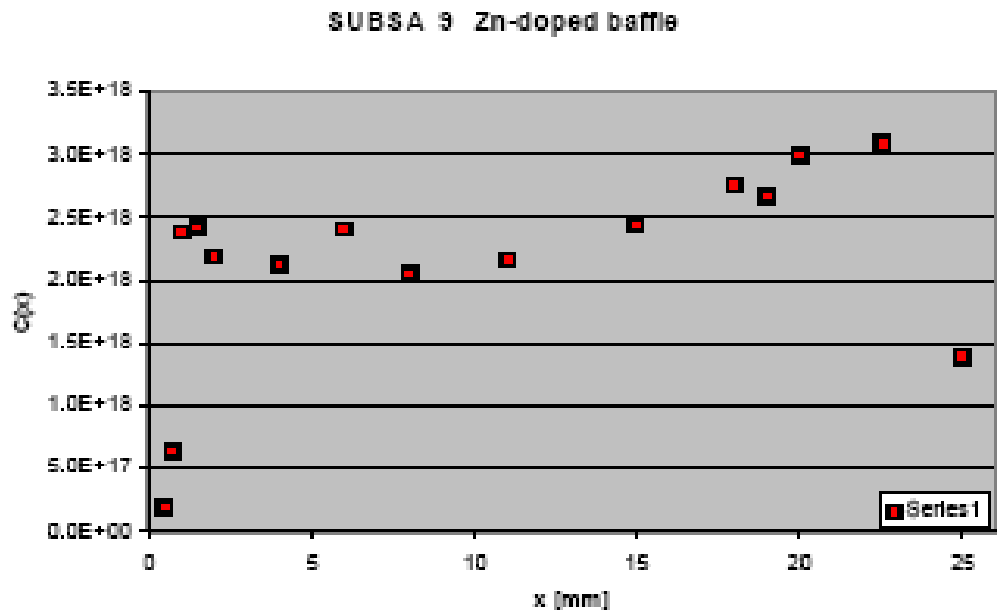
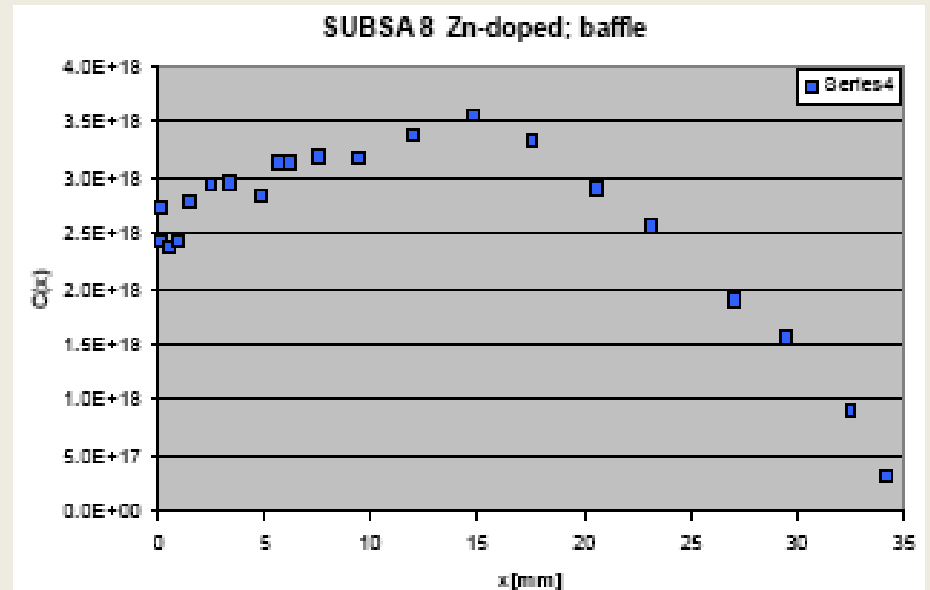
# SUBSA-10 Dopant Segregation Profile

(less than 0.1 mm of the seed was melted)



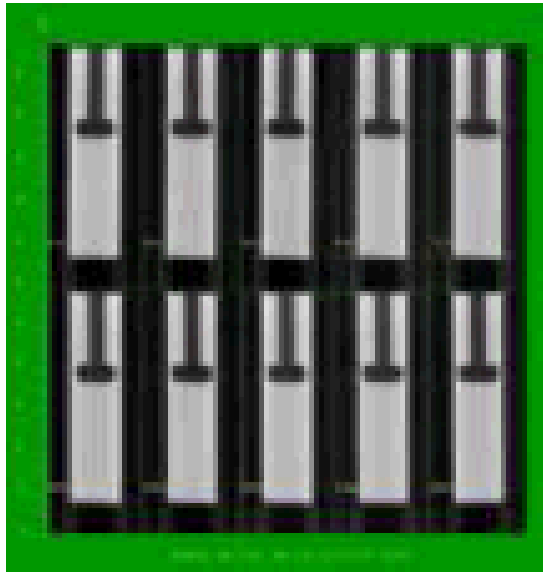


# SUBSA-08 and SUBSA-09 Dopant Segregation Profiles (approximately 2 mm of the seeds were melted)

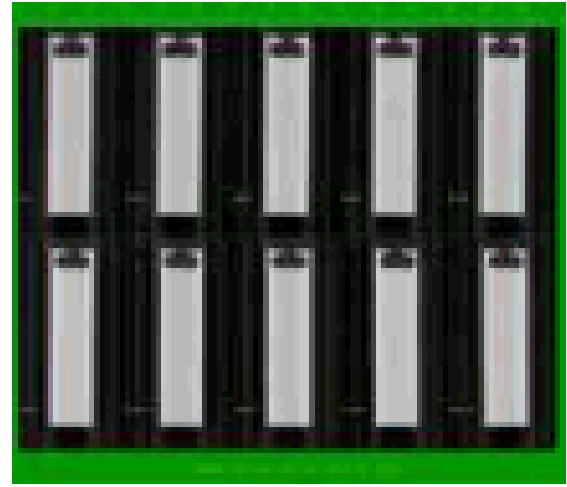


# Computed tomography measurements of final baffle positions

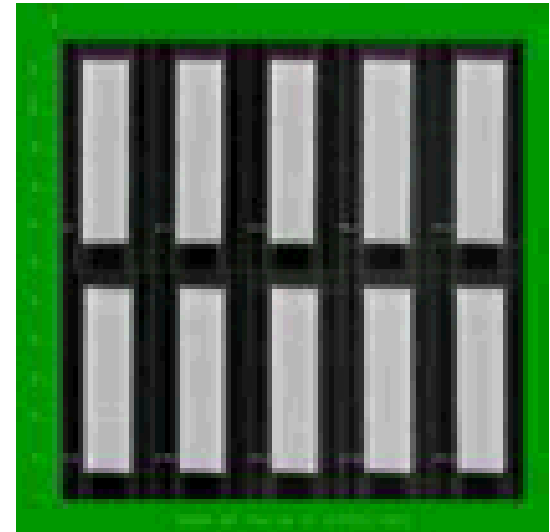
SUBSA-09



SUBSA-08

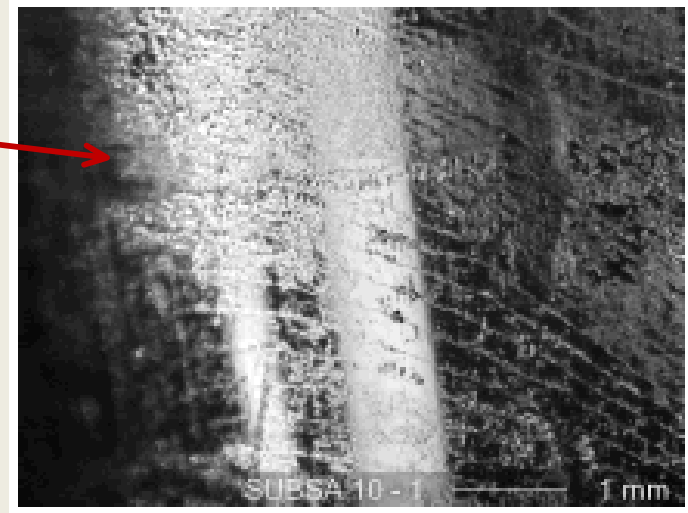


SUBSA-10



# Surface Characteristics of SUBSA-10

Surface striations related to de-wetting with a discontinuous movement of the melt-crucible contact line



Partial de-wetting



Complete de-wetting



## Conclusions

- Two samples, SUBSA-08 and SUBSA-09, grown with a carbon baffle, show absence of the diffusive initial transient
- SUBSA-10, grown without a carbon baffle, shows a short diffusion-controlled transient, in agreement with the Smith et al. equation.
- Partial de-wetting occurred in SUBSA-10, apparently disturbing the diffusive transport of Zn in the melt
- The appearance of partial dewetting in SUBSA-10 coincides with the departure from diffusion-controlled segregation
- An order of magnitude analysis shows that the thermocapillary convection on the meniscus surface leads to a melt velocity of  $\sim 2$  cm/s.